1: Pelzer S-5 (1940-1941) 1945 AL1 Southeast Asia AL1

recuperate quickly when the area is again allowed to revert to bush."[38]

Several of the forest services of Southeastern Asia have made a rather successful use of the shifting cultivator in their endeavor to reforest the land. They have combined shifting culture and silviculture by hiring shifting cultivators to cut mature trees and to sow or plant new trees on cut-over or burned-over land. For this the cultivators are paid a small wage. In addition they are allowed to grow their own crops for one or two years between the rows of young trees. This system, known as the "taungya forestry system," was developed in 1856 by the German forester, Dietrich Brandis, while he was Superintendent of Forests in Pegu, Burma.[39] It is ingenious in that it recognizes the habits of the shifting cultivator and fits them into a modern forest economy instead of persecuting the cultivator and forcing him to give up his traditional culture. This system has been used in the teak forests of Java since 1871. The forest service makes a contract[40] with the peasants of Java according to which the peasants are to prepare the land and plant and take care of teak trees (*Tectona grandis* L.) in return for a small sum of money and the right to plant such crops as maize and red pepper (*Capsicum annuum* L.) between the rows of teak. The cultivation of upland rice is discouraged, and the planting of cassava, peanuts, castor beans, and tobacco usually is not allowed (Figs. 40, 41). [1]

The taungya forestry system is an excellent way of getting pure stands of commercial timber. The typical forest of the tropics is expensive to exploit because of the large variety of trees which it contains, many of which have little or no commercial value.[41]

As important as reforestation is soil erosion control. Where shifting cultivation is practiced in mountainous regions it often causes such acceleration in the rate of erosion that the rivers are choked with sediment and periodically do great flood damage. Flood control could be achieved in most cases by completely closing the headwaters and watershed areas to cultivators. On more gentle slopes the clearings should be rather narrow, should parallel the contours, and be separated by belts of forest. If at the same time the forest uphill were protected by fireguards, the clearings would have a chance to close quickly again so that the soil would be

[38] Worthington: Science in Africa, 1938, pp. 378–379.

[39] *Taungya* is the Burmese term for the temporary field of the shifting cultivator, a term that the foresters have adopted. E. P. Stebbing in his work, The Forests of India, Vol. 1, 1922, p. 376, writes:

"Brandis, moreover, recognized that the very system which, till then, had destroyed teak forests might be utilized to produce them, . . . and as early as 1856 an attempt was made in Prome district to sow teak in regular rows, together with the rice scattered by the toungya [*sic*] cutters. Twenty years afterwards this attempt had grown into a regular system, by which areas were being annually stocked with teak at a cost far below that of regular plantations." See also *Ibid.*, Vol. 3, 1926, pp. 415–428.

[40] Becking: "De djaticultuur op Java," 1928, pp. 50–52.

[41] Heske: "Der tropische Wald," 1939, p. 414. Heske's article gives an excellent short account of the forests of Southeastern Asia and points out that they are on the whole much easier to exploit than are the forests of tropical America because of the abundance of cheap labor.

[1] [See p. 41, cut 41 -- Analy 1]

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groups resemble those of salt-tolerant vegetation on European beaches of which spinifex is a sample. Behind this shore grows a distinctive strip of what may be called *beach woodland*, sometimes referred to as beach forest. On reefs, on muddy shores and estuaries, where there is diurnal flooding at high tide, the *mangrove* forest develops. When the shore is rocky, lowland forest may reach high tide mark. In this vegetation seeds and fruit are waterborne so that currents are an important means of dispersion.

Well-developed beach woodland forms as a ribbon rarely more than 200 ft. inland from the shore and contains tree types not usually seen elsewhere and often reaching 90 ft. in height. The typical tree, the casuarina (Equisetifolia, rhu, ru, tjemara) is rather like a conifer to look at and is related to Australian she-oaks. Sometimes the casuarina is in pure stands; at places the strip includes screw pines (Pandanus), the leathery-leaved Calophyllum, Inophyllum and Barringtonia. Coconut palms, which can take root after nuts have been dispersed by sea-currents, are now prominent in beach woodland areas as a planted crop, but they occur self-sown everywhere through the islands.

Mangrove forests are widely distributed on sedimenting shores throughout Southeast Asia. The fringe of mangroves is interrupted where rocks or cliffs come to the sea and when drainage control has diminished the silt from terrestrial sources. Where mangroves develop, silt is being deposited at a fast rate (sometimes to a thickness of 1½ in. annually); the mangrove thus both raises the surface level and progressively presses farther seaward. Whether mangroves grow only where silt is being deposited or whether they cause silt deposition by their root system, obstructing tidal currents and flood run-off, is still disputed. Possibly both processes operate together. The net effect is one of raising the land level and reclaiming land from the sea. In addition, the wood of mangroves is valued for firewood and charcoal; the bark is sold extensively for tanning. The mangrove trees are of some thirty species, all with structural adaptations enabling them to root in unstable muds and to tolerate daily inundation of their root system by saline tidal water. In addition to the tree, there are shrubs, herbaceous plants and ferns (particularly Aerostichum aureum). The trees are evergreen, sometimes 100 ft. tall, mostly with shining, leather-like leaves, small flowers, and unusual root systems. Some (as Rhizophora) have many roots supporting the trunk which begins well

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argest zone covers Burma, Siam and Indochina, while the counterpart in Eastern Java, the Sunda Islands and New Guinea covers a much smaller area, with local variants due to insularity. These zones are identical with the dry areas of Fig. 10. 137

In the rainy season, Monsoon Forest resembles Tropical Rain Forest. Its tree heights are less, the foliage not so profuse, and the spacing more open. Only the undergrowth remains fairly green for the whole year; the rest of the vegetation sheds leaves in the dry season, when the forest has a bare, stark appearance. Herbaceous plants, lianes and bamboo are common but epiphytes are unusual and the herbs almost disappear in the very hot dry season. Among the trees, Acacias and Albizzias are especially common and Leguminosae are prominent.

Some observers distinguish between wetter and drier types of Monsoon Forest, both transitional from Tropical Rain Forest to Tropical Desert, the latter being outside Southeast Asia.

Monsoon Forest is mostly of mixed species but sometimes a single species dominates, possibly as a result of selection through repeated burning. Of these, teak forests (Tectona grandis) are characteristic and important commercially, occurring in Northern Burma, Northern Siam, Eastern Java and the Moluccas. So valuable has teak proved itself that some existing forest areas are actually re-plantations of it. Teak has thick hard-cased seeds which are fire resistant. Its saplings come through fire successfully and the pure stands are thought to have been the result of natural selection on these lines, since it is fairly certain that forests of teak alone do not occur under natural conditions. Teak reaches to heights of over 120 ft., the lower half of the tree being straight and unbranched under forest conditions. Undergrowth is negligible and the ground is covered with brittle teak leaves which often cup, forming mosquito-breeding places in the wet season. [313]

Resembling the teak forests in origin, eucalyptus forests have developed in the eastern islands as migrants from Australia, occurring naturally only in New Guinea, Timor, the Lesser Sundas, Celebes and the Philippines.

Another single stand deriving from the Monsoon Forest by selection, is bamboo forest. Considerable areas almost exclusively occupied by bamboos are found in the northern parts of Southeast Asia, with small patches in East Java. Bamboos in great variety grow everywhere in Southeast Asia and they have been planted 313 137

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extensively because of their usefulness structurally and domestically, but continuous stands become established only where the dry season is very marked and where shifting cultivation is known to have been practised extensively. Bamboos are giant perennial grasses of about a hundred species, with woody stems and woody roots. They grow in clumps and may be evergreen or deciduous. Some bamboos flower at long intervals (25-70 years) and their seeds are fire-resisting. Constant friction between the dry woody stems may cause forest fires and help to produce that selective process which leads to stands of bamboo.

Monsoon Dry Forest, an open wooded landscape containing very few species, may be found over large areas of Burma, Siam and Indochina in association with poor soils. Known as *indaing* in Burma and *padeng* in Siam, this forest develops where rainfalls are not much above 40 in. per annum, and it may merge on the equatorial side into Tropical Rain Forest and on the other into dry or thorny savannah vegetation. Within Monsoon Dry Forest trees are widely spaced, tending to be stunted forms of Dipterocarpaceae and distinctly deciduous.

Secondary Monsoon Forests.—Considerable areas of savannah found in Burma, Siam, Indochina and the Eastern Indies are secondary growths after a removal of the natural Monsoon Forest. Savannah is open country of tall, coarse grasses, occasionally having a few scattered bamboos or low trees and very much associated with long dry seasons whose effects are aggravated by poor or porous soils. Savannah merges into Monsoon Dry Forest and is often covered with low palms (Borassus flabellifer), and contains prickly pears, spiny cactus-like plants, and similar thorny scrub.

(3) Mountain Vegetation

Vegetation steadily and often imperceptibly changes with altitude and the resulting types are much the same, level for level, throughout Southeast Asia. All but the very highest mountains are forested, though the trees on exposed summits are dwarfed; only in New Guinea and Yunnan are the heights great enough entirely to prevent tree growth and produce an alpine vegetation. Young volcanoes may be treeless for pedological, rather than for climatic reasons.

Above about 2,000 ft., at most points of Southeast Asia, large

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industries derived from mining, but also regarding the general prospect of local industrialisation. While good qualities are mined in Tonkin, coals of most Southeast Asia territories are of inferior grade and ill-suited to major industrial uses. This is an obstruction to developing the extensive iron ore deposits because only Tonkin coal can be used for smelting. Mineral oil does not suit heavy industrial processes though diesel type heavy oil engines are widely used in existing local industries, and will probably be the source of power for any new dispersed industries.

Water power resources are huge and widely distributed. So far only minor harnessing of water has been done and it is remarkable that, although Southeast Asia people have evolved skilled techniques of using their water supplies for agriculture, they have shown little traditional interest in its use as power, even for textiles and rice-milling which might seem obvious needs. The high and fairly even rainfalls of the upland areas are assets for water power; only in the loose materials of volcanic flanks, as in Java, is there any great difficulty about the necessary damming. On the other hand, where the rivers have water enough and suitable relief, they are remote from the centres of greatest population concentration, where a labour corps is available. Hence of the 6½ million horse power estimated to be available from the waterways of the East Indies islands, hydro-electric stations with only a capacity of .2 million kilowatts had been installed and three-quarters of them were in Java. Outside the equatorial zone, the irregular régime of rivers renders them less suited for water power, and scarcely any hydraulic power is developed in Burma, Siam and Indochina. A single installation derived from a dam at Chenderoh across a major stream, the Perak River, motivates many tin mines of West Malaya. On the other hand, electrification (from imported coals) has become widespread throughout the urban centres of the whole region. It is possible that a dispersed industrialisation based on water power might rapidly develop on lines apparent in parts of Central Europe, and Southeast Asia might, by industrialising on water power and heavy oils, skip the phase of steam industrialisation through which both Europe and Eastern United States passed. On this basis the bauxites of Southeast Asia could come into full exploitation.

Apart from teak extraction, Southeast Asia forests have provided little international trade, which is more remarkable now that

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the resources of temperate forests show signs of exhaustion. The defects of tropical forest for a timber industry have been explained; it is not clear why no interest has been shown in a pulping industry based on tropical trees most of which have the advantage of relatively quick natural replacement. Pulping of tropical woods may yet solve the world paper shortage, especially as woody or fibrous tropical plants might be cropped for pulping instead of depending on predatory deforestation as is the case in the pulping industries of temperate areas today.

The forests, however, supply the basic domestic fuel of the region. Apart from westernised suburbs of the town, charcoal and wood are the normal means of cooking, in which respect the domestic life continues today much as it did two or three centuries ago. Wealthier residences may use electricity which is mostly steam-generated from imported coals, but domestic coal-gas is uncommon. Domestic heating, of course, is a question which does not arise in these climates. For their illuminants the bulk of the people turn to their trees, to coconut oil, second to which is paraffin oil from within the region. Urban areas are electrically lit.

From Commodity Production to Local Processing

Because the production of primary agricultural commodities like rubber, copra, medicinal plants, and tapioca, all the basis of industrial processes elsewhere, has been the function of Southeast Asia territories over the first third of this century, culminating in an immediate prewar export valued at nearly $1,000 million per annum, processing and manufacturing of these commodities may cease to be done overseas and become the basis of industrialisation within Southeast Asia to make use of local power resources and of the margin of time available among rural populations. A tendency in this direction was very evident in Java where skill and incentive were present; rubber goods, textile printing, preparation of medicines, confectionary and refining essential oils had grown to significant proportions by 1941 and the enforced isolation of the war years should have intensified them, though a resumption of normal trading relations will oblige these industries to so organise that they meet the rival processed goods of zones as varied as India, Europe and the Far East. The influence of India as a source of manufactured goods was evident, particularly in textiles, before the war and could become even more prominent after India's